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An Experiential Model for Cross-Institutional Collaboration and Entrepreneurship in Engineering Education

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An Experiential Model for Cross-Institutional Collaboration and Entrepreneurship in Engineering Education: A Case Study

Abstract

Preparing engineers to address complex societal challenges requires educational models that integrate technical rigor with entrepreneurial thinking, social awareness, and cross-disciplinary collaboration. This paper presents a case study of a cross-institutional, experiential learning project centered on the development of a modular, ADA-compliant wheelchair ramp system manufactured from recycled polymers. The project evolved from an academic prototype into a manufacturing-oriented, startup-driven initiative through collaboration between two universities and multiple industry and nonprofit stakeholders. Drawing from both student and educator perspectives, the paper examines how this structure enabled the integration of materials research, design-for-manufacturing, life-cycle assessment, and supplier engagement within a single capstone experience. Students operated in a highly self-directed environment that required balancing technical design decisions with real-world constraints, fostering an entrepreneurial mindset through systems thinking and stakeholder coordination. The paper further highlights how institutional collaboration enabled resource sharing, expanded mentorship capacity, and created a more realistic engineering context. Ultimately, this work proposes a flexible, transferable model for embedding entrepreneurship, interdisciplinarity, and real-world impact into engineering education.

Introduction

In today's evolving technical and economic landscape, engineering students are increasingly expected to address complex and interdisciplinary societal challenges. As a result, undergraduate engineering education across the country has seen an emphasis on bolstering student preparation with teamwork, communication, and workplace expectations [1]. Engineering students are found to have a lack of formal education in entrepreneurship [2]. There have been institutional efforts to integrate entrepreneurship components into introductory engineering courses, core curriculum, and capstone courses [3] which have shown that experiential learning activities influence engineering student outcomes. This same study highlighted that multidisciplinary programs exert a stronger positive impact on students' entrepreneurial competencies [4], compared to programs situated solely within engineering departments. This shift reflects the growing notion that engineers now more than ever must collaborate across disciplines and engage with diverse perspectives in order to understand contributions from other disciplines [4] beyond the creation of solutions that are technically viable, socially responsible and economically viable. There seems to be a growing trend of promoting both interdisciplinarity and cross-institutional collaboration signaling an expansion of disciplinary boundaries in both course design and program design for engineering students [5]. This aligns with the projections and demands expected by different governments and organizations embedded in education and educational policy making.

Despite these growing efforts in academia to integrate interdisciplinary entrepreneurial thinking in young engineers, there is limited clarity surrounding how such multi-discipline cross-institutional collaborations are structured, implemented, and assessed within undergraduate engineering programs. In the context of cross-institutional collaboration, prior literature has primarily examined these efforts through high level theoretical lenses, as exemplified in a systematic review [5] including global preparedness frameworks, project-based learning, and cross-institution collaborative learning models, among others. These experiences are able to draw on different institutional strengths, mirror the complex multi-stakeholder landscape engineers face in the real world, and can boost creative behaviors and entrepreneurial thinking[2]. However, while these frameworks highlight the potential value of cross-institutional collaboration, they provide limited insight into how such collaborations are implemented at the capstone level. Prior work suggests that capstone projects incorporating entrepreneurial objectives are particularly effective because they require students to operate under uncertainty and real-world constraints [6]. What remains underexplored is how cross-institutional collaboration can be structured within capstone experiences to intentionally support this form of entrepreneurial and interdisciplinary learning.

This paper presents a case study of such collaboration involving a cross-institutional capstone project between Brown University and the University of Connecticut (UConn) centered on a real-world accessibility challenge that could potentially improve the lives of thousands of users. With that in mind, engineering students explored issues of inadequacy, situational environments, and ethical implications associated with accessibility and inclusive design[7]. The project was treated as a student-led, independent-study, capstone project with a focus on the development of an affordable modular ADA-compliant accessibility ramp manufactured from recycled polymers. Projects like these can serve as a practical response to real-world accessibility challenges that combine technical feasibility with sustainability goals and social responsibility [8]. The project originated at the University of Connecticut, where it operated for two prior years as a capstone project under the guidance of faculty collaborators and an industry sponsor who co-founded the associated startup. In its third year, the project expanded to include Brown University, where it functioned as a capstone-level independent study, led primarily by a single student in collaboration with a Brown University faculty advisor.

Written from both student and educator perspectives, this paper examines the educational structures that enabled this collaboration and presents detailed takeaways and impacts of the experience. In doing so, this paper offers an example of learning outcomes along with a flexible model that can be adapted to create other tailored cross-institutional, entrepreneurship-focused engineering experiences at the capstone level of undergraduate engineering education. Specifically, the paper highlights outcomes related to (1) the development of entrepreneurial mindset through uncertainty, ownership, and real-world constraint; (2) interdisciplinary and cross-institutional collaboration across engineering, design, sustainability, and business domains; (3) applied technical learning through materials research, design-for-manufacturing, and standards-driven design; and (4) stakeholder engagement and professional communication involving faculty, industry sponsors, and external partners.

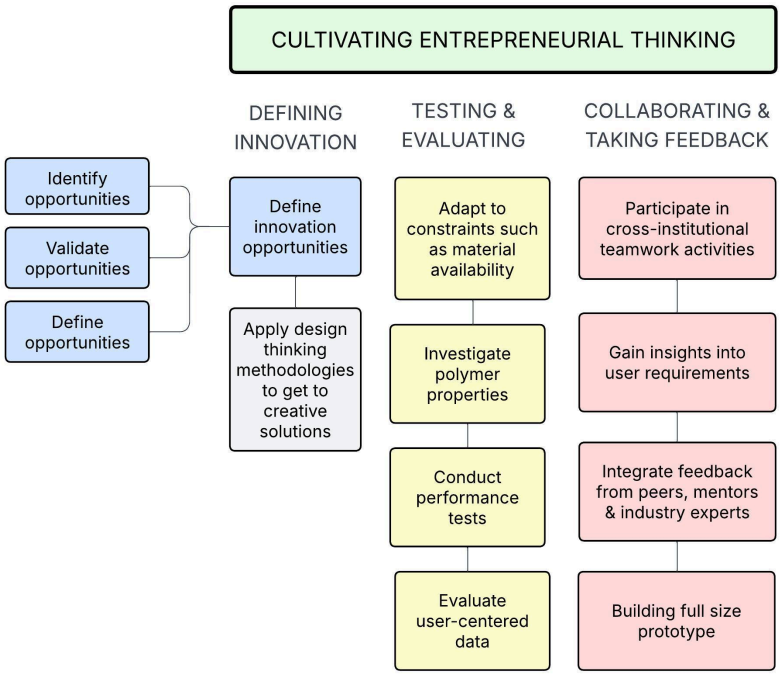

Figure 1. Summary of Entrepreneurial Approaches

Educational & Institutional Context

The collaboration between UConn and Brown University, both R1 institutions, began at the International Design Conference in New York, where Dr. Jorge Paricio Garcia, Associate Professor at UConn and Co-director of the Krenicki Arts and Engineering Institute, attended a lecture by the Director of the Brown Design Workshop, Dr. Louise Manfredi. After the event, Dr. Paricio initiated a conversation about potential synergies between both institutions, particularly around ideas for revamping UConn's Innovation Shop. This initial dialogue sparked interest in exploring collaborative opportunities that extended beyond facilities, towards joint educational initiatives.

Shortly after, faculty members and shop technicians from both universities organized reciprocal visits to each other's facilities. These visits were instrumental in identifying complementary resources and capabilities, which helped UConn refine its vision for the Innovation Shop upgrade. The collaboration was further strengthened by existing professional connections: the

Brown Design Workshop director had previously worked with professors who were colleagues of Dr. Paricio, creating a foundation of trust and shared academic values that lowered barriers to inter-institutional coordination.

The partnership evolved organically when a Brown engineering student contacted Dr. Paricio after looking at his research and published works. Recognizing the student's enthusiasm, Dr. Paricio invited him to join an ongoing research project, which became the cornerstone of this cross-institutional initiative. The project had been running for multiple years at this point in time and was towards the end of the design phase.

The educational motivation for this collaboration aligns with prior research emphasizing the value of real-world constraints in engineering education, which found that key competencies including adaptive problem solving, creativity, teamwork, and project management, are strongly linked to action-oriented, project-based learning [9]. Despite this, traditional engineering instruction often struggles with mismatches between student learning styles and traditional teaching methods. Most students are visual, sensing, inductive, and active, while engineering instruction tends to be auditory, abstract, deductive, and passive, and this can lead to poor performance and loss of potential [10]. To bridge this gap, the author recommends strategies such as clarifying objectives, teaching with specific examples, data, or problems, balancing concrete and abstract content, promoting active and cooperative learning, and designing fair assessments. These are all approaches that emphasize a student-centered and experiential learning methodology that is better aligned with contemporary engineering practice.

Experiential learning has been tested successfully , with Worcester Polytechnic Institute (WPI) as a leading example. By embedding project-based learning throughout its entire undergraduate curriculum in engineering, WPI has equipped students with skills beyond technical knowledge, including applying theory to real-world problems, fostering critical thinking, creativity, and adaptability. A recent WPI alumni survey confirmed the enduring impact of this model [11], reporting that project experiences significantly enhance teamwork, communication, leadership, and problem-solving abilities—competencies that employers consistently rank as highly valuable [12]. Additionally, repeated exposure to collaborative, open-ended projects build confidence and resilience and has ensured that graduates can also thrive in an unpredictable future, teaching engineers who can be innovative, adaptable, and who can lead with a global perspective.

The Senior Design Programs in the School of Mechanical, Aerospace and Manufacturing Engineering at the University of Connecticut provides much of the academic and organizational framework for the experiential and collaborative model described in this paper. As a two-semester capstone aligned with ABET design criteria, this program, used in the entire College of Engineering, integrates engineering analysis, design methodology, ethics, communication, and exposure to real-world industry needs. Projects are co-mentored by faculty and industry engineers, ensuring that students have the chance to engage with authentic technical and entrepreneurial challenges.

The program combines two complementary components: (1) The academic component focusing on applying engineering fundamentals and structured design processes within ABET's requirements for a culminating major design experience, and (2) the investigation of a sponsor-defined technical problem, to develop viable and relevant solutions. This dual structure cultivates both engineering competency and an entrepreneurial mindset.

In the Fall semester, teams establish a problem statement, conduct research, and generate conceptual solutions. Students meet weekly with their faculty advisor and with one another, and maintain regular communication with their industry mentor to ensure alignment with sponsor needs. By semester's end, teams deliver several refined solutions that are supported by preliminary analyses or prototypes, which are documented through presentations and a structured written report that includes technical data such as codes and standards in engineering. The spring semester focuses on finalizing a written report, and a detailed design. As students move towards choosing a single solution to focus on, they develop and evaluate a prototype (or simulation model), and refine their previous design, with support from faculty and industry advisors. This work culminates in a final presentation and a demonstration.

At Brown, a typical Engineering capstone consists of a semester to year long course in which a student has substantial autonomy over a project definition and execution. Specific courses are designated as capstone fulfilling courses due to the presence of a strong design component. Capstone-eligible courses vary by concentration (e.g. Electrical, Biomedical, Design, etc.) each of which offer specific projects to a students focus area. Notably, these capestones do not always include formal industry sponsorship. Alternatively Brown students can opt to complete an independent project in place of a capstone course. The process for approval includes the submission of a research plan, and advising plan to a faculty member who oversees project milestones and assessment. Due to this structure, the project is driven by the student's interests and commitment level, with evaluation based on the student and faculty-determined deliverables and the extent of the student's intellectual contribution.

To clarify institutional differences in regard to capstone projects and resources within the context of the project, Table 1 summarizes the distribution of key resources, capabilities, and responsibilities across participating institutions. This breakdown provides a concrete example of how complementary institutional strengths can be structured to support cross-institutional, entrepreneurship-focused engineering experiences.

Contribution Area	**UConn University**	**Brown University**	**Shared / Either**
Legal & Patent Guidance			✓
Industry Sponsorship Framework	✓		
Industry Advisor Access	✓		
Material Procurement Support			✓
Material Testing & Prototyping Facilities			✓
Flexible Capstone & Independent Study		✓	
Student Driven Project Initiation and Ownership		✓	
Project Continuity (Multi-Year Pipeline)	✓		
Regional Industry Connections			✓
R1 Research Infrastructure			✓

Table 1. Distribution of Institutional Contributions and Shared Capabilities in Cross-Institutional Collaboration

Notably, the capabilities identified in the "Shared/Either" category do not *require* duplication across both institutions to enable effective collaboration, rather, the presence of these resources within at least one institution is sufficient to support project success. However, when both institutions possess capabilities, it introduces additional flexibility, in how work is distributed, further strengthening the collaboration.

Importantly, while this case study focuses on collaboration between two R1 institutions, the underlying structure is transferable beyond inter-university partnerships. Larger R1 institutions are able to, and do, replicate similar dynamics internally by leveraging collaborations across departments, research centers, or design institutes, where complementary resources and educational structures already exist. In such cases, interdisciplinary institutes or co-directed programs can reduce administrative barriers by enabling faster alignment and decision-making without requiring formal cross-institutional approval processes. Conversely, this case may be particularly valuable for smaller institutions that may lack access to established industry sponsorship pipelines or specialized research infrastructure. By partnering with institutions that possess these resources, smaller programs can extend the scope of their capstone experiences without needing to independently develop such capabilities.

Project Overview

The project itself involved supporting the development of a modular wheelchair ramp from preliminary design phases to a manufacturing-ready product. Over the 15-week semester, the two main project teams (UConn & Brown) worked on interdependent and overlapping components of this project, resulting in frequent cross-institutional communication.

The UConn team undertook a comprehensive revision of the work completed by the two preceding Senior Design teams, beginning with a thorough review and recalculation of the Finite Element Analysis (FEA) for the previously selected material to validate its performance under expected loads. This process included an evaluation of other alternative materials to ensure that no other option offered superior physical properties or greater availability. In parallel, the team assessed the modular integrity of all primary components, refining the design to enhance durability and ease of assembly. Using UConn's strong connections with the manufacturing industry, the team engaged in discussions with potential manufacturers to identify feasible production strategies and forecast the most efficient manufacturing processes for the main components. To align with sustainability goals, the bill of materials was revised to maximize the use of recycled polymers, and filament was procured to initiate preliminary 3D printing tests on the chosen material. Additionally, the team developed a fully modular 3D CAD model of the ramp system, incorporating detailed designs for component connections in collaboration with Civil Engineering students. Throughout this process, particular emphasis was placed on optimizing joinery between ramp segments to ensure structural integrity while integrating aesthetic considerations into the railing design.

The Brown team contributed complementary technical and entrepreneurial expertise, with a primary focus on materials research and testing, environmental impact analysis, ADA compliance, design for manufacturability, and supplier and manufacturer outreach. Material testing activities included the preparation and mechanical characterization of recycled polymer specimens to assess tensile behavior and variability relative to manufacturer datasheets, informing material selection and process feasibility.

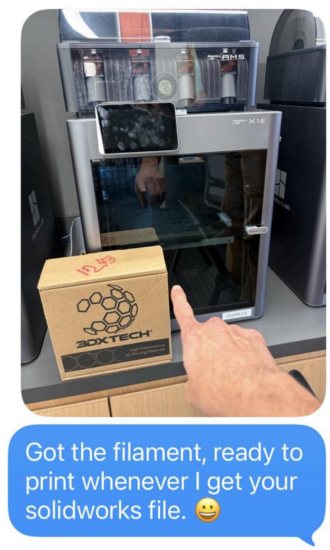

Figure 2. Correspondence between Brown and Uconn Teams

In parallel, environmental considerations were evaluated by the Brown team through preliminary life-cycle assessment to compare the embodied carbon and material efficiency of recycled polymer components relative to conventional aluminum ramp systems. The Brown team also led detailed design-for-manufacturing and design-for-assembly (DFM/DFA) analyses to evaluate the suitability of ramp components for extrusion, injection molding, and thermoforming processes. CAD-based draft, thickness, and assembly studies were used to refine component geometries in close coordination with the UConn team's structural and modularity work, resulting in a highly integrated design approach. Additionally, an initial supplier and manufacturer outreach was conducted, to identify regional and national partners capable of producing glass-fiber-reinforced recycled polymer components at scale, gathering data on recycled content availability, minimum order quantities, tooling constraints, and production tolerances which laid the framework for subsequent discussions with manufacturers led by the UConn team.

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
-Earth Friendly Project Inc. (501c3) - University of Connecticut -Brown University -Material Suppliers -Local Manufacturers -Accessibility & Housing Agencies -Grantmakers & Impact Investors	- Material & design optimization - Material and structural testing - Supplier and manufacturer partnerships -Manufacture pilot ramp -Marketing and outreach	-Accessible: ADA compliant, modular ramp installable without professionals -Affordable: Costs less than typical aluminum or concrete ramps -Sustainable: Made from recycled plastics and designed for end-of-life recyclability -Mission-Aligned: Social impact + circular economy innovation Aesthetic Value	-Personalized consultation for homeowners - Buy back program	-Homeowners -Landlords -Housing authorities -Healthcare facilities -Non-profits
	Key Resources - Proven modular CAD design and FEA validation -IP/license -Partnerships with universities -Brand credibility in sustainable, inclusive design		**Channels** -Website Sales -Hardware Stores (home depot) -B2B sales -Bulk sales to housing agencies/non-profits	

Cost Structure	Revenue Streams
-Material procurement -Manufacturing and tooling -Labor and assembly operations -R&D and testing - Marketing and distribution logistics	-Direct ramp sales to individual consumers and contractors -Bulk orders to agencies, housing authorities, and institutions -Licensing agreements for regional manufacturers -Maintenance and replacement component sales

Figure 3. Eco Entry Ramp LLC Business Model Canvas [13]

Engineering Outcomes as Evidence of Learning

To ground the educational discussion in concrete engineering outcomes, this section briefly summarizes the technical scope and deliverables achieved through the ramp development project.

1. **ADA Compliance and Structural Requirements**

Design constraints were anchored in ADA ramp guidelines, including maximum slope (1:12), minimum clear width (36 in), landing dimensions, handrail geometry, edge protection, and slip resistance. While the ADA does not prescribe explicit structural load limits, industry benchmarks (>100 psf distributed load) were adopted to guide structural design. Finite element analyses conducted by prior teams, combined with component-level validation planning, indicated that the modular ramp geometry could meet deflection and load-bearing expectations when manufactured using reinforced recycled polymers. Compliance requirements informed geometry decisions, module lengths, handrail extensions, and landing configurations throughout the design process

2. **Materials Research**

The project evaluated recycled polymer candidates for outdoor, structural accessibility applications, with a focus on balancing mechanical performance, durability, manufacturability, and environmental impact. Early design iterations explored recycled polyethylene terephthalate (rPET), while later stages prioritized glass-fiber-reinforced recycled polypropylene (GF-rPP) due to its favorable strength-to-weight ratio, stiffness, and processability. Literature review and supplier outreach informed expected trade-offs related to recycled content percentage, UV stability, surface finish, and material strength. Analyses were performed to ensure materials met targets for tensile strength, flexural performance, and safety factor consistent with ADA ramp requirements and existing ramps.

3. **Environmental and Life-Cycle Considerations**

A preliminary life-cycle assessment (LCA) was conducted to compare the environmental impacts of the proposed recycled-polymer ramp system against conventional materials such as aluminum and pressure-treated wood. Using an early-stage cradle-to-gate boundary and open-source datasets, the analysis identified material production and manufacturing as dominant contributors to carbon intensity. Results indicated that recycled polymer components exhibit substantially lower embodied carbon per kilogram than aluminum, with total system impacts driven primarily by aluminum leg assemblies and hardware. These findings informed design priorities focused on mass reduction, modular replacement, and design for disassembly to support circular end-of-life pathways

4. **Supplier and Manufacturer Engagement**

Supplier and manufacturer research mapped the regional and national ecosystem capable of supporting recycled-polymer ramp production. Outreach focused on identifying partners with experience in recycled resin compounding, glass-fiber reinforcement, UV stabilization, and extrusion or injection molding of structural components. Data collected included recycled content availability, minimum order quantities, mechanical property datasheets, compounding flexibility, and pilot-scale feasibility. This engagement enabled early alignment between design intent and manufacturing realities, reinforcing the entrepreneurial and systems-level learning objectives of the project

5. **Design for Manufacturing and Assembly (DFM/DFA)**

A structured DFM/DFA evaluation was conducted using CAD-based analyses to refine part geometries for scalable production. Components were assessed for draft angles, wall-thickness uniformity, undercuts, and assembly complexity to determine suitability for extrusion, injection molding, or thermoforming. Manufacturing pathways were compared based on tooling cost, per-part cost, tolerances, and production scalability. These analyses resulted in targeted recommendations for component-specific processes including extrusion for linear deck boards and injection molding for modular connectors, while maintaining modularity and ease of assembly as core design priorities.

6. Material Testing

Material validation focused on establishing feasibility rather than full certification. Tensile testing of ASTM D638 Type I and Type II 3D printed specimens produced via fused deposition modeling (FDM) was conducted using 30% GF-rPP to characterize Young's modulus, ultimate tensile strength, and elongation at break. Results showed consistent mechanical behavior and expected reductions relative to injection-molded datasheet values, aligning with published literature on additively manufactured fiber-reinforced thermoplastics. A broader testing plan was developed to assess flexural stiffness, creep, UV durability, and slip resistance using accessible laboratory methods, emphasizing repeatability and property retention rather than absolute optimization. These validation efforts supported informed material and process decisions while remaining appropriate for an academic capstone context

Project Mechanics

The eight-person team consisted of four mechanical engineering seniors from UConn, a UConn Associate Professor-in-Residence in the School of Mechanical, Aerospace and Manufacturing Engineering, a Brown University Associate Professor of the Practice in the School of Engineering, an industry sponsor, and UConn Professor Emeritus in the School of Public Policy, and a design engineering senior from Brown as shown in Figure 4.

Figure 4. Students assembled from UConn and Brown University, at UConn's Storrs Campus, Fall 2025.

This wide variety of faculty, students and industry collaborators from varying backgrounds resulted in a diverse project team that advanced the milestones across a mix of disciplines, namely engineering, industrial design, sustainability, policy and regulations, business organization and entrepreneurship.

It has been recorded in previous cross-institutional capstone projects, that programs like this can face several limiting factors that can hinder its full potential: institutional barriers – – with lack of alignment between departments being the main contributor; – budget constraints; challenges related to faculty promotions or tenure; conflicts of interest or competing priorities; curriculum-related issues; and obstacles in communication and logistics [5].

Additional difficulties arise from inconsistencies in institutional cultures and norms, as well as time management and course content differences across collaborating entities [5]. To maintain alignment across all parties and ensure steady progress throughout the semester, weekly meetings were scheduled involving the industry sponsor, the UConn team, and the Brown team. These meetings ensured that everyone remained up to date with the established timeline, project direction, and next steps. In addition, each institutional team—UConn and Brown—held its own internal weekly meetings to monitor progress and prepare for joint discussions. Across the semester, the teams maintained a structured communication schedule. A total of 35 documented meetings were held, including:

- 9 tri-party meetings involving both university teams and the industry sponsor
- 12 internal Brown team meetings
- 14 internal weekly UConn team meetings

Additional ad hoc meetings were conducted among faculty members and potential industry partners, as the teams explored relevant technologies and manufacturing processes, assessed design options, and gathered a broader context.

Figure 5. Dr. Manfredi and Dr. Paricio Garcia meeting for the first time at Brown University's Campus, Fall 2025

This meeting structure followed the general expectations of Senior Design I at UConn, in which student teams are required to maintain consistent communication with faculty advisors, interact with mentors every two weeks, and work collaboratively every week, all while keeping in mind a strong problem statement, expanding the production of prototypes, brainstorming and evaluating potential solutions, and identify the analytical and experimental components of their proposed approach. It also exceeded the expectations of an independent capstone project in Engineering at Brown, which requires biweekly meetings between student and advisor at a minimum

This coordination framework culminated in a comprehensive engineering project with real startup potential, requiring extensive communication across industries, institutions, and educational areas. Entrepreneurship was the consistent thread throughout this project, as any engineering or design decisions had to consider the limited resources available in this startup setting, one of the key differentiating factors as compared to other traditional engineering capstone projects. With eight team members at institutions over fifty miles apart, a second major differentiator was coordinating project logistics. This complex project environment provided invaluable experience in navigating similarly complex real world business scenarios.

Assessment & Evaluation

To assess the tangible outcomes of this cross-institutional, experiential learning model, several quantitative and qualitative indicators were tracked throughout the semester. These metrics focus on project scope, coordination complexity, stakeholder engagement, and workflow structure.

One major success indicator was the capacity for parallelization of work enabled by the cross-institutional structure. Unlike traditional single-team capstone projects, the cross-institutional structure enabled substantial parallel progress across multiple technical and entrepreneurial domains. During the 15-week semester, materials testing and characterization, DFM/DFA analyses, supplier and manufacturer outreach, and structural design refinement occurred concurrently rather than sequentially. It was common for three to six distinct development avenues to be pursued at any given time across the entirety of the project team, from both universities. This parallelization reduced dependency bottlenecks and allowed design decisions to be informed simultaneously by material performance, manufacturing feasibility, and sustainability considerations. This structure, however, necessitated a higher frequency of coordinated communication, reflected in the sustained cadence of tri-party and internal meetings across institutions.

A second indicator was the scale of institutional and disciplinary involvement. The project involved two academic institutions (University of Connecticut and Brown University) and engaged students and faculty across multiple disciplines. These included mechanical engineering, design engineering, product design, civil engineering, sustainability, fine arts, entrepreneurship, public policy, and even urban studies expertise. This interdisciplinary engagement reflects a far broader scope than typical capstone projects situated within a single department or institution, usually representing only one discipline.

A similar pattern emerged in the breadth of stakeholder engagement. External engagement extended beyond the nine academic collaborators and industry sponsors, to include multiple manufacturing partners, supplier contacts. In total, the project engaged:

- One industry sponsor with startup leadership responsibilities
- Six potential manufacturers across extrusion, injection molding, and thermoforming processes
- Multiple material suppliers provide data on recycled polymer availability, reinforcement options, and processing constraints.
- One Engineering technician overseeing material testing.

In addition to these structural indicators, industry sponsor feedback served as an external measure of project effectiveness. Feedback from the industry sponsor consistently emphasized both the pace and quality of progress achieved during the semester. In written correspondence, the sponsor noted:

> "You've put in serious effort this semester, and it shows. The ramp designs are standing tall, the testing numbers are getting solid, and the ideas for next steps are sharper than a carving knife."

Additional feedback highlighted the integration of sustainability and design quality:

> "You've engineered more than a ramp—you've engineered bragging rights. And your designs are proof that sustainability can be stylish."

Early communications also reflected confidence in the student's professional engagement and contribution to the team:

> "I have a feeling you'll be a great asset to the Eco-Entry Ramp project team."

From a faculty perspective, informal comparative evaluation suggested that the combined Brown–UConn team achieved a level of technical and organizational progress within a single semester comparable to what prior UConn-only teams had accomplished over a full academic year. This comparison reinforces the quantitative indicators of parallelization and scope expansion enabled by the cross-institutional structure.

Taken together, these quantitative indicators and external evaluations suggest that the cross-institutional structure contributed to both accelerated technical progress and alignment with professional and entrepreneurial expectations commonly associated with industry-facing engineering practice.

Student Perspective

From the student perspective, this project functioned as a highly self-directed, capstone-level experience resembling a professional co-op, requiring sustained levels of initiative, coordination, and interdisciplinary problem solving. The student, a senior studying Design Engineering at Brown University – a multidisciplinary program situated at the intersection of mechanical engineering and industrial design – sought to use the capstone requirement as an opportunity to apply a broad set of technical, design, and systems-level tools in a real-world context. While the existing Design Engineering capstone structure allowed for the application of technical skills, it generally lacked the entrepreneurial complexity and direct industry engagement that the student aimed to experience prior to entering professional practice

The project first emerged as a potential capstone opportunity during the spring semester of the student's junior year, when an informal conversation with a faculty member from the University of Connecticut evolved into a discussion of ongoing work aligned with the student's interests. Brown University's flexible academic structure enabled the student to pursue this opportunity through a capstone independent study, developed collaboratively with the industry sponsor and an external faculty advisor from UConn. Formal approval was obtained through the Design Engineering independent study capstone proposal process, with requirements including:

- A significant and definable design component
- Must be based on the knowledge and skills acquired in earlier course work
- Incorporation of appropriate engineering standards
- Project addresses multiple realistic constraints

Additional requirements included addressing several learning objectives, determining evaluation criteria, and mechanisms for project oversight. Notably, the approval process itself required alignment among institutional expectations, industry priorities, and faculty advising, a challenge that mirrored the coordination demands encountered throughout the project.

A significant and unexpected benefit of this collaboration was the opportunity to engage directly with the design processes and documentation standards of an ABET-accredited engineering program. While Design Engineering at Brown University is not ABET accredited, collaboration with the UConn team exposed the student to structured design reviews, formal milestone tracking, and industry-facing documentation practices required under ABET guidelines. This exposure provided additional rigor and structure that complemented the student's prior design-focused training and broadened their understanding of how engineering design is practiced across institutional contexts.

The startup nature of the industry partnership further expanded the student's learning experience beyond traditional technical roles. Rather than operating within a narrowly defined engineering scope, the student was required to navigate responsibilities spanning materials research, design-for-manufacturing analysis, supplier and manufacturer outreach, and broader business considerations. Supplier engagement in particular demanded balancing affordability, material availability, performance requirements, and long-term scalability which were decisions that required systems thinking and negotiation rather than purely technical optimization. These experiences reinforced the entrepreneurial dimension of the project by situating engineering decisions within economic, logistical, and organizational constraints.

Overall, the project functioned less like conventional coursework and more like a professional engineering placement, while retaining the mentorship, reflection, and resource access characteristic of an academic environment. This hybrid structure allowed the student to operate with a high degree of independence while benefiting from regular faculty guidance and institutional support. The result was an experiential learning context that closely aligned with contemporary expectations of engineering practice, where engineers are frequently required to coordinate across disciplines, institutions, and stakeholder groups.

Finally, the cross-institutional nature of the collaboration exposed the student to differing educational cultures and engineering approaches shaped by institutional priorities, available resources, and curricular emphasis. Differences between the Brown and UConn teams, such as those regarding design philosophy or procedural structure, created opportunities for complementary problem-solving and iterative feedback. This exchange fostered a deeper level of collaboration and resulted in design outcomes that were more robust and innovative than those likely achievable within a single institutional context. From the student perspective, this experience underscored the educational value of cross-institutional collaboration as a mechanism for broadening engineering judgment and reinforcing interdisciplinary thinking.

Educator Perspective

Each educational institution has a different approach in the setup and supervision of classes labeled as Independent Studies. These often require a high degree of flexibility and customization, as they are designed to accommodate unique student interests and project goals that fall outside the prescribed curriculum of classes. Overseeing such classes demands a significant time commitment from faculty, which is frequently uncompensated for, and therefore represents an additional professional responsibility beyond standard teaching loads. Despite these challenges, the experience can yield substantial benefits for faculty members, particularly when the independent study is project-based and situated within a cross-institutional and entrepreneurship focused setting.

When considering the value of the experience for the faculty involved, three key professional development areas emerged. First, it presented professors with an opportunity to engage in research transcending institutional boundaries, thus making it a true interdisciplinary collaboration that enables sharing knowledge and structural resources such as laboratories, prototyping facilities, and industry connections. This type of collaboration not only enriches the academic environment but also strengthens institutional partnerships that can lead to future joint ventures or grant opportunities.

Second, the experience allowed for the development of collaborative mentoring and the testing of a non-traditional teaching model. For this project, faculty members were able to co-create learning experiences that emphasized design thinking, sustainability, and accessibility, while guiding students through complex problem-solving processes. This approach encouraged faculty to refine pedagogical strategies, adapt to the different institutional cultures, and integrate entrepreneurial thinking into engineering education. Such adaptability and pedagogical experimentation are increasingly valued in contemporary academia.

Third, working closely with a highly motivated team of students on a real-world project proved to be an intellectually rewarding and professionally enriching experience. Faculty had the chance to witness the transformative impact of project-based learning on student growth. As the team navigated technical challenges, ethical considerations, and user-centered design principles, this interaction created a sense of a shared purpose and accountability and reinforced the importance of mentorship in shaping future engineers who must be socially responsible and innovation-driven.

Ultimately, while independent studies require significant faculty investment, they offer a unique platform for advancing educational innovation, strengthening institutional ties, and in this particular case, cultivating entrepreneurial mindsets among students. These experiences highlight the potential of creating more flexible, cross-institutional models that can prepare graduates for the new challenges of modern engineering practice.

Lessons Learned

This project's success can be attributed to the unique blend of institutional values across UConn and Brown. On one hand Brown is highly flexible and welcomes students to leverage the open curriculum and student-led educational initiatives. This flexibility results in the exploration of diverse topics through engineering, fostering a strong startup culture and many avenues of expertise across the school. On the other hand, UConn follows a time-tested culture of seeking senior design sponsors under the guidelines of the undergraduate design director and another senior faculty member. It uses a structured set of guidelines following ABET accreditation requirements, paired with a tight alignment of sponsors and companies looking for collaboration, across many disciplines in engineering. Often these engagements result in yearly commitments of companies that want to break down large engineering investigations into smaller, yearly commitments with student teams.

The combination of these two institutional approaches towards engineering education bring to fruition powerful projects such as the highlighted case. This is further amplified when paired with a strong faculty alignment across institutions who are looking for collaboration enables opportunity. The key piece that enables these projects is the unique and flexible mechanisms of an independent study, allowing for a student to bring these two entities together.

One of the most effective aspects of this collaboration was the level of student ownership enabled by the independent study structure. Because responsibility for coordination, decision-making, and progress did not reside within a single course or institutional framework, students were required to navigate ambiguity, negotiate priorities across stakeholders, and take accountability for outcomes. This environment closely resembled professional engineering practice and reinforced entrepreneurial behaviors such as initiative, adaptability, and systems-level thinking. Faculty mentorship across institutions further amplified this effect by exposing students to multiple perspectives on design rigor, feasibility, and impact.

Despite its successes, the collaboration also revealed important limitations. Differences in academic calendars, course structures, and institutional expectations required ongoing negotiation and occasionally slowed decision-making. Faculty involvement demanded additional time and coordination beyond standard teaching responsibilities, raising questions about scalability without formal institutional support. Furthermore, the model relies heavily on motivated students and faculty champions, which may limit adoption in contexts lacking such individuals. Recognizing these constraints is essential for institutions considering similar initiatives.

Importantly, the multi-year structure of the project suggests a pathway for continuity beyond a single academic term. By building upon prior work and maintaining industry sponsorship, successive student teams can incrementally advance both technical development and educational impact. Future iterations may further formalize assessment methods, expand cross-disciplinary participation, or explore partnerships with additional institutions, reinforcing the potential of these projects as a sustained educational framework rather than a one-time collaboration.

Conclusion

Building on the quantitative and qualitative evidence presented, this case study suggests that cross-institutional, entrepreneurship-focused capstone experiences can provide a uniquely authentic learning environment that combines technical rigor with real-world stakeholder complexity and student ownership. Rather than proposing a one-size-fits-all program, the intent of this paper is to extract transferable conditions that enabled the collaboration to function effectively across two institutions and an industry sponsor. The following informal model synthesizes these enabling conditions into a set of components that can guide other programs seeking to implement similar cross-campus experiential learning efforts.

1) **Regional proximity**- This enables the use of shared resources and tools (such as labs, expertise, manufacturing networks) that may require a physical collaboration aspect.
2) **Complementary university profiles** - Specifically, there is a large benefit of the partnership of universities of different sizes and that share different educational philosophies and values. As in the case study, this diversity results in increased knowledge sharing and differing areas of expertise which can be drawn upon.
3) **One institution with an established project pipeline** - Whether in the form of industry sponsor, incubator, or other real-world connection, having an established project pipeline will accelerate the impact of the partnership.
4) **Faculty flexibility -** It is essential that Faculty who are willing to advise outside traditional course boundaries, specifically due to the fact that this work will likely be in addition to predefined yearly responsibilities. Therefore, these projects may be best advised by non-tenured faculty who likely have the capacity and flexibility to take on such projects.
5) **Goal alignment -** having clear shared goals in terms of project scope and impact.
6) **Student Ownership and Motivation -** A project of this nature requires a highly motivated student (or team) capable of driving the collaboration, willingness to operate with ambiguity and take leadership roles.

7) **Institutional flexibility** - Specifically flexibility in terms of allowing students to pursue independent studies, and utilize these for capstone credit. This Capstone or capstone-adjacent structure that legitimizes the work of the student.
8) **Communication infrastructure** - Due to the many institutions and stakeholders involved in this type of project a comprehensive meeting and resource coordination system is required to ensure alignment across stakeholders and proper distribution of material
9) **Project continuity mechanism** - Project should have multi-year viability and faculty carryover)

Ultimately, this paper proposes an informal model for cross-institutional, entrepreneurship-focused engineering experiences grounded in the conditions observed in this case study. Together, these components form a flexible framework that other institutions can adapt to develop their own cross-institutional, experiential engineering collaborations.

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